NATIONAL AERONAUTICS AND SPACE ADMINISTRATION (NASA)
NASA Ames Research Center (ARC)

Partnership Opportunity Document (POD) – (RFI #NNA15ZPX0002L)

For

Solar Occultation Constellation for Retrieving Aerosols and Trace Element Species (SOCRATES) Mission

July 2015

Solar Occultation Constellation for Retrieving Aerosols and Trace Element Species (SOCRATES) Mission

1.0 Introduction and Scope

This Partnership Opportunity Document (POD) addresses announcement number NNA15ZPX002L, through the NASA ARC Programs and Projects Directorate Small Space Craft Division [1]. NASA ARC seeks a partner to partners that can provide or develop a spaceflight-qualified micro-satellite spacecraft bus for the **Solar Occultation Constellation for Retrieving Aerosols and Trace Element Species (SOCRATES)** Mission within the Earth System Science Pathfinder Program.

ARC will be submitting a proposal in response to HQ NASA announcement number NNH15ZDA008J, Earth Venture Mission - 2. This AO [2] is expected to result in a single step competitive process; selected proposals will proceed directly into a science mission flight project.

This POD is being issued to select a teaming partner to help prepare candidate mission proposal submittal(s). There will be no exchange of funds between the teaming partners for the portion of this partnership opportunity dealing with the preparation of proposal(s). Funding will be available for subsequent technology development should the proposal(s) be selected. Selection of proposal(s) and subsequent mission systems development does not commit the Agency or ARC to subsequently partner on future Announcement of Opportunities.

2.0 Technical Objectives

2.1 ARC Mission - NASA/ARC is interested in partners that can provide or develop a spaceflight-qualified micro-satellite spacecraft bus for the **Solar Occultation Constellation for Retrieving Aerosols and Trace Element Species (SOCRATES)** Mission. A constellation of these Observatories will be deployed to Low Earth Orbit (LEO) and will be used to measure the composition of gasses in the Upper Troposphere/Lower Stratosphere (UTLS) region of the atmosphere via the Solar Occultation method with a government provided instrument; hereafter, referred to as 'payload'. Six required flight units + qualification unit, spares, and engineering models are planned for the mission. The proposed micro-satellite bus should conform to the notional specifications provided below.

Note: (Observatory = micro-satellite spacecraft bus + payload)

2.2 Notional Specifications for the micro-satellite Spacecraft bus are:

- Operate Instrument twice per orbit (Sunrise/Sunset)
- Point at Full Sun (nominal) or Deep Space for Calibration purposes
- Provide payload a radiative heat transfer surface to space environment
- Provide stable thermal interface to SC avionics and Instrument
- Transmit (downlink only) 1 pass per day/satellite, 10 min duration
- Total Observatory Volume: not to exceed 30cm x 30cm x 20cm

- Launch Vehicle Mass Capacity: 250kg for all observatories and Launch Vehicle adapter (Vendor must carry 30% margin on mass capacity to fit within Pegasus shroud)
- **Power**:
    - Solar Arrays co-aligned with instrument aperture (270mm x 145mm Instrument face pointed at sun).
    - Battery will be sized to support up to a 35 minute discharge with all subsystems active without exceeding a 60% depth of discharge.
- **Mechanical**: The Spacecraft bus shall be designed to survive shock and vibration loads specified in General Environmental Verification Standards (GSFC-STD-7000A) levels. https://standards.nasa.gov/documents/detail/3315858
- **Environments**: The Spacecraft bus will be designed and tested to GEVS (GSFC-STD-7000A) space environments.
- **Radiation tolerance**: 10 krad total ionizing dose and handle single-event upsets
- **Propulsion**: None
- **Attitude control**: Three Axis, Reaction Wheel control with torque rod momentum dumping presumed, though other solutions may be considered. A 'safe-mode' must be provided that can maintain a power-positive state without use of reaction wheels, star tracker, or IMU if used for your solution.

	Reqt Value	CBE Performance	Margin	Comment
Pointing Control	3 arcmin (0.05 deg)	0.007 deg	714%	3σ
Jitter (frequencies > 20 Hz)	5 arcsec	1 arcsec	1000%	RMS
Slew Rate	> 0.1 deg/sec	3 deg/sec	3000%	

- **Communications**: Command and telemetry capability, compatible with Near Earth Network (NEN) antennas. Downlink of at least 1.65 Gbit/day telemetry volume (downlink). Commanding 2 kbps or greater (uplink) will be performed daily on weekdays. Note NEN compatibility requires CCSDS Packet format Blue Book standards, see http://public.ccsds.org/publications/default.aspx for reference.
- **S/C C&DH**:
    - Minimum 10-160 MIPS (10-160 Mhz) Rad tolerant processor board. Minimum RAM ECC (128M). Minimum 1 Gb Data storage available to the payload. Software & Hardware SEU mitigation. Minimum Rad Hard Parts: Flash, Watch Dog, Reset & Power Circuits. Compatible Power and I/O Boards
- **Flight Software (FSW)**: Provide all necessary FSW for Command and Telemetry processing, spacecraft health and status monitoring, memory management, attitude control modes (detumble, sun-safe, solar inertial, nadir point, slew, thrust), sensor processing, fault management and response, scripted relative and absolute time scripts, and payload interface.
- **Payload Accommodation**:

- **Power**: Provide up to 21W of peak switched power, and 1W of unswitched power (for payload survival heater(s)). Payload orbit average power will not exceed 17W (22W peak). Power can be unregulated in the range of 9-15V from bus. Provide a redundant switched power path using separate HW components, ground command-selectable. Resettable overcurrent protection of the bus shall be provided if the payload draws more than 5.5A.

- **Ground**: Provide separate returns for analog and digital grounds using a single point star grounding scheme. Payload will be isolated from any bus structure grounding.

- **Data**: provide RS-422 asynchronous binary comm links for sending Payload commands and receiving payload telemetry at a minimum 19.2 kbps data rate. Bus flight software will need to monitor payload data stream for fault indicators and perform pre-determined payload safing procedures. Safing procedures/scripts must be modifiable on-orbit.

- The bus shall be able to route ground commands to the payload and store on-board scripts of payload commands that can be triggered to run by timer or ground command.

- Provide at least 25% spare pins in the payload interface connector

- Provide an interface for an analog NASA/GSFC STD S-311-P-18K compatible temperature sensor that will monitor the payload temperature when switched power to the payload is off.

- **Mechanical**: provide 275x 175 x 145 mm volume for payload accommodation, and a mounting strategy for Payload. Payload volume should be contiguous and contain one 275 x 145 mm external face pointed at the SUN (co-aligned with solar arrays).

- **Mass**: Support up to 12kg payload mass

- **Thermal**: Thermally isolate bus from payload volume, while providing ability for payload to radiate excess heat out external (payload and bus) surfaces. Specific thermal solution for the payload will be the responsibility of the payload.

    - Nominal Operating temp range -40 to +65C
    - Instrument interface -15 to +35C

- **Mass properties**: Bus CG will need to be known/measured to +/- 2mm in all 3 axes.

- **Launch Requirement**: Spacecraft bus solution must be compatible with common US Launch providers.
- Orbit characteristics:

	Season	Altitude (km)	Inclination (deg)	BETA (deg)	Solar Flux (W/m2)	Albedo	Earth IR (W/m2)
Cold Case	**Summer**	**650**	**+/-55-60**	**Circa 4 deg/day**	**1320**	**0.2**	**218**
Hot Case	**Winter**	**475**	**+/-55-60**	**Circa 4 deg/day**	**1420**	**0.4**	**240**

- **Flight Duration**: Minimum 3 Year Operational Life in LEO operating between 475km & 690KM.
- **Reliability**: PS= Exceeds 0.95 (for individual observatory)
- **Shelf Life**: 9 months minimum (spacecraft bus may need to be held in bonded stores while awaiting launch accommodation or payload delivery).
- **Launch Considerations**: During launch and Observatory deployment into LEO, the Observatory may be completely unpowered for up to 45 minutes and tumbling in orbit. During that period, the bus will be unpowered. The bus will automatically power up after this preset time, gain attitude control, deploy solar arrays, and achieve a power positive safe mode.
- **Electromagnetic Interference (EMI)/ Electromagnetic Compatibility (EMC)**: Bus Radiation and conduction levels need to be documented so NASA can perform compatibility analysis with the payload to determine if filtering or shielding is required. Document generated fields and strengths and note any susceptibility concerns at specific frequencies. The MicroSat bus shall be EMI/EMC self-compatible.
- **Contamination**: The bus and any components shall be delivered VC+UV (Visibly clean, plus ultraviolet) at a cleanliness Level of 500 B. Bus and components with high off-gassing concerns, like wiring insulation, will be baked out prior to delivery. Any specific clean room requirements should be specified, e.g. 100K.

2.3 Responsibilities of Selected Partner - The selected respondent/partner is expected to provide support using their own resources to help develop and prepare the proposal(s). This work will involve meetings with the ARC engineers and scientists to help define the end-to-end project objectives, performance requirements, technology readiness level assessments, comparative analyses, and technology maturation plans. The preparation of proposal(s) will include cost estimation for proposed technology developments. The period of performance for this POD is expected to last 12 months, after notification of selection.

The partner will be responsible for implementing the technology development work plan identified in proposal(s) selected for development.

3.0 POD Responses

Responses to this POD shall address the following.

(1) Organization/Company Info:
   a. Name and address of firm,
   b. Cage Code and DUNS Number (if available),
   c. Points of contact name(s) with phone number(s) and email address(es),
   d. Website (if applicable), and name of parent organization (if applicable).
   e. Business size (Based on NAICS code) and/or Socioeconomic designation (i.e., large, small, SDB, WOSB, VOSB, SDVOSB),
   f. Average annual revenue for past 3 years and number of employees;
   g. List of relevant partners/customers covering the past five years (highlight relevant work performed, contract numbers, contract type, dollar value of each procurement),
   h. Whether the firm is under a GSA Schedule Contract for this product (based on the above and below technical specifications identified in this announcement). Please provide contract number if applicable.

(2) Technical Solutions: Please provide the following:
   a. Proposed technical specifications of a MicroSat bus meeting the specifications above. If unable to meet any specification, indicate your solution for reduced performance with rationale.
   b. Proposed solution for qualification of the MicroSat bus.
   c. Optional: Proposed solution for the integration and system level qualification of the payload with the MicroSat bus.
   d. Optional: If the MicroSat bus utilizes a vendor-provided ground data system solution, please provide the proposed solution for the ground data system. Include how NASA operations personnel and facilities could be integrated with the solution.
   e. Proposed solution for engineering, test and operations support.
   f. Maturity of the technology at a subsystem level (i.e., what parts of the system have been flight qualified, when and by whom or under what project), description of Technology Readiness Level (TRL), and near-term plans / approach for qualification of any components that do not yet have flight heritage.
   g. Rough Order of Magnitude (ROM) cost/schedule estimate -- broken down by the elements listed above (bus design and delivery, bus qualification, payload integration, ground data system and operations support) -- timeline for the design, fabrication, and testing of a spaceflight-qualified system (in FY16 dollars). The ROM should include (1) engineering development unit, (1) SW simulator, (2) flight units and (1) flight spare.

(3) Information regarding existing or planned facilities, ground support test equipment plans and vendor capabilities.

(4) Identification of partnerships (if any) represented in the response. This includes but is not limited to joint venture partners, potential teaming partners, prime contractor (if potential sub) or subcontractors (if potential prime).

Special Notice Instructions: The technical POC at ARC regarding this opportunity and partnering with Ames is Bruce Yost. Potential partners are encouraged to submit questions in writing to the identified POC, Bruce.D.Yost@nasa.gov, and Umetria.Y.Thomas@nasa.gov. Pertinent information from questions and answers will be shared with all interested parties, without disclosing the identity of the sources of the questions. When submitting questions, reference **RFI NNA15ZPX002L – SOCRATES MICROSAT BUS.**

4.0 Submission Instructions

Responses to this notice will serve as the basis for selection of proposal partners. Additional information may be requested to help in the selection process. Submitted responses will be maintained for possible future opportunities for 1 year. Responses will be treated as proprietary information and controlled as such.

Interested firms are requested to submit their response to this announcement via email only to Umetria Thomas at email umetria.y.thomas@nasa.gov, no later than 4:00PM, PST on Thursday, August 20, 2015. Submissions shall be compatible with and accessible using Microsoft Office or Adobe Acrobat software applications. When responding, reference **RFI NNA15ZPX002L – SOCRATES MICROSAT BUS**.

Documents and attachments should be in PDF format. Files should not be greater than 15 pages for the technical response (no less than 12 point Times New Roman font except in figure captions). Due to mailbox limitations, attachments should not exceed 10MB.

5.0 Selection Criteria for Awarding Partnership Opportunity

ARC plans to make selection based on the submitted materials only. Selection criteria will be consistent with the desire to encourage cost effective partnerships between the Government and Industry. The information requested in Section 3.0 will allow subject-matter-expert evaluators to determine how well the respondent's technology is responsive to NASA needs.

Selection Criteria

ARC will evaluate the responses based on alignment with the Agency's goals, compliance with the announcement requirements, feasibility and suitability of the concept and its match to Ames' interest and capabilities.

In addition to the information requested above, the following areas are considered highly important in the evaluation of responses to this notice:

- Degree of flight heritage contained in the overall flight system proposed.

- Ability to work as part of a government-industry team that may include other industrial partners, academia, and/or foreign partners.

- Innovative technical and partnering approaches that could be used to minimize cost without increasing overall mission risk.

- Demonstrated track record of developing low-cost spacecraft on-time in a schedule-constrained environment and at the agreed upon cost.

- History of delivering spaceflight systems with proven technical and cost performance.

- Depth of experience in spacecraft bus and/or payload management/development, including but not limited to: systems engineering, bus and/or payload fabrication and test, subcontract management, quality management, safety management, materials and processes/contamination control, payload integration and test support, observatory functional and environmental testing, shipment to the launch site, launch vehicle integration support, preparations for and the conduct of launch and early orbit checkout operations, on-orbit operation support, and sustaining engineering support including flight software maintenance.

6.0 Acronyms List

ARC	Ames Research Center
EDT	Eastern Daylight Savings Time
EMC	Electromagnetic Compatibility
EMI	Electromagnetic Interference
ESSP	Earth Sciences Pathfinder Program
FSW	Flight Software
GFE	Government Furnished Equipment
GEVS	General Environmental Verification Standards
LEO	Low Earth Orbit
NEN	Near Earth Network
POD	Partnership Opportunity Document
SOCRATES	Solar Occultation Constellation for Retrieving Aerosols and Trace Element Species
UTLS	Upper Troposphere/Lower Stratosphere

7.0 References

The following links provide additional information.

[1] http://www.nasa.gov/centers/ames/codep/index/#.VafRa_lVhBc
[2] https://prod.nais.nasa.gov/cgibin/eps/synopsis.cgi?acqid=165223